

The Governance of Research and Innovation

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Abstract - As the task for research and innovation management is increasingly complicated, institutional design - according to many, is or should be both reactive and flexible. Scholars who speak of multi-level governance or network governance, emphasize on cooperation, flexibility and networks. It is argued that over the last two decades, the classical model of hierarchical and integrated government has been gradually replaced by a more horizontally structured and fragmented arrangement. Large reallocation of authority and tasks between new actors at many levels has become a trend. In this research a total of fourteen countries are analyzed in an attempt to understand institutional design for S&T governance. Our analysis covers a total of fourteen countries and aims to provide a different view of modern governmental reform and a framework for the understanding the nature and patterns of governance.

Keywords- S&T Governance, Government Organization, Policy Cycle, Competence Chain, Coordinating Mechanism

I. INTRODUCTION

Government reform for better innovation governance is a global phenomenon. For many countries, innovation capabilities nowadays are already seen as fundamentals for improving national competitiveness. The need to innovate administrative system and to inject a culture of innovation into the governance structure is manifest, and several reforms have been implemented or are currently unfolding across countries. The characteristic of a public governance system can be understood through examining the allocation of legal authorities and tasks across many administrative entities and representatives. Governance patterns differ due to a great variation of vertical and horizontal distribution of responsibilities. Since a wider distribution of tasks across many government bodies is not uncommon, it is found that mechanism for integration and coordination have become critical to keep the whole system away from fragmentation [1][2]. Recent changes and issues of national S&T governance structures provide us with understanding of trend and possible future strategies [3][4].

II. GOVERNMENT S&T SYSTEM

Organizations in the government administrative structure have distinct authorities and functions, and operate according to administrative rules defined by constitution, law or regulations. Hierarchy of authority and specialization of

function are necessary, in order to avoid overlapping duties and to prevent the competition for limited resources among organizations and their representatives [5]. As can be observed, organizations are set up and interact with each other according to this distinctive complying relationship and division of labour, forming a tight chain in the process of policy making and implementation [6]. This rule commonly exists in many S&T governance systems across different countries. Vertical distribution of functions means the division of labor in the policy cycle, ranging from the political leadership at the top, to ministries, managing agencies and finally, R&D institutes at the bottom, running through the entire policy cycle (decision-making, coordination, planning, execution and management) [7]. The policy cycle can be simplified to the following tiers:

- 1) Decision-making and coordination of policies (President or Prime Minister)
- 2) Planning, promotion and execution of S&T policies (ministries)
- 3) Planning and execution of R&D projects (R&D institutes)

Or it can be extended to include six or more tiers as follows:

- 1) Decision-making of policies (President or Prime Minister)
- 2) Coordination of policies (Minister-without-portfolio, or executive Ministers)
- 3) Planning and formulation of policies (ministries)
- 4) Promotion and execution of policies (agency)
- 5) Management of R&D (funding service)
- 6) Execution of R&D projects (R&D institutes)

Many governments have less hierarchy in the distribution of vertical functions in S&T policy making [8]. Although the Prime Minister is in charge of the country's macro-level policies, Ministers are at the core of decision making, and are fully responsible for sectoral policies. As to national S&T development, one or two ministries (normally Ministry of Education and Science or Ministry of trade and Industry), are fully responsible for planning and management of both policies and R&D programs. In the parliamentary system of government, coordination for S&T policies are usually done by Ministers in cabinet meetings, chaired by the Prime Minister or sometime through Ministers of responsible ministries. Sometimes experts are gathered to provide advice to the Prime Minister and Ministers. Apart from regular cabinet meetings, there is no special or regular establishment for collective decision-making [9][10]. Countries such as Germany, Norway, Denmark, Sweden and Switzerland are typical examples. The government only has advisory committees within the Cabinet for policy consultation. The

same pattern can be observed in the presidential system of government, such as in the United States. Experts are invited to advise the president on major directions and decisions. But departments are responsible for the full range of policy planning and execution [11]. For the above mentioned countries, there is a quite simple division of labor across the entire policy cycle.

However, in the same parliamentary system of government, there are also countries where the government place much more emphasizes on collective decision-making [12]. The Prime Minister and the Cabinet, which means the council of all Ministers, are expected to share the political responsibility together. In other words, the Cabinet work together to reach policy decisions or sometimes to draft strategic plans, while independent ministries are responsible for the detailed planning and execution. Since the Prime Minister and the Cabinet intend to work collectively for S&T development, discussion and consultation within the Cabinet will be intensified. More administrative support is needed to deal with macro-level policies. In order to enhance cabinet's capability on making decisions and primary planning, permanent working mechanism (special committees) for policy formulation and consultation are established within the Cabinet. Administrative Ministers of S&T are appointed to assist the operation. After the decisions and plans are made by the Cabinet as a whole, ministries are responsible for the follow-ups. UK, Japan, Israel and the Netherlands are fine examples of the above mentioned system. This type of operation will cause a more sophisticated division of labor at the vertical dimension.

In some dual-executive system countries (semi-presidential or semi-parliamentary) such as France, Korea, Finland and Taiwan, the duty of the Cabinet differs according to whether the President or the Prime Minister is the leader of the government [13]. For instance, the President is in charge of the country's macro-level policies in Korea and France, while the Prime Minister is responsible in Finland. However, in the dual-executive system of government, both leaders could involve in macro-level policies in different fields and degree. Both of them will establish their own mechanism to serve their duties. Korea and France are typical examples. The President has his own advisory committee and high-level council for decision-making and primary planning. The Prime Minister, on the other hand, functions as the chief executive for the president and coordinates policies. He may also establish own working mechanism within the Cabinet (or involve some advisory committees too). Although ministries are responsible for policy planning and execution, many of their managerial tasks can be shifted to agencies or funding serving organizations such as academy or councils. Like in most countries, agencies and councils are responsible for the formulation, management and evaluation of R&D programs, which will ultimately executed later by R&D institutes. An even more complicated pattern of functions across the policy cycle emerges.

However, there are many factors shaping the pattern of vertical distribution of functions, such as constitutions, party politics, and in particular, existing government system (semi-presidential, presidential or parliamentary system of government) [9][11][13]. The complexity of vertical distribution of function will increase, if:

- 1) Macro-level policies are made by the Cabinet a whole, not by a selected executive Minister in the independent ministry. While the whole Cabinet is responsible, which means a system of collective decision-making is adopted, the capacity of the Cabinet Office needs to be strengthened. Mechanism such as administrative Ministers and permanent committees will be set up within the Cabinet.

- 2) The execution and promotion of policies are not done by ministries themselves but by independent agencies; or the planning and management of R&D programs are done by non-governmental professional service.

- 3) The country adopts a semi-presidential system. The share of responsibilities between the President and the Prime Minister in political system will decide whether a lengthy process of decision-making is required.

Horizontal distribution of function means division of labor in S&T competence building and exploitation [14]. In the government system, ministries and agencies are set up for specific domain of development (research, economy, education, national defense, transportation, etc). Regarding S&T development, ministries are positioned to play certain functions in terms for competence building and exploitation. The S&T competence chain includes the establishment of infrastructures, supporting basic and applied research, technology development, and application [15]. Government resources such as R&D budget are also distributed according to the function and needs of responsible ministries. Through the examination of the relative position in the competence chain and also the distribution of R&D budget, the role and importance of ministries can be better understood. This will help to understand if S&T policies are distributed among ministries for formulation and execution, or are the responsibilities of few ministries.

Factors influencing the pattern of horizontal distribution of function are complicated, including departmentalism, functional specialization (infrastructure, research, development and application), and also the allocation of resources [9] [13]

Countries with less division of labor mean one or two major ministries control most of the R&D resources and work in coordination with a small number of ministries in other fields [16-18]. Denmark, Sweden, Germany, Switzerland, New Zealand offer good examples. There is one super ministry whose function cut across the entire competence chain, from S&T infrastructures to application. The super ministry manages and allocates more than half of government R&D budget. Along with the super ministry, there are only two or three ministries participating in the planning and management of S&T development. In France and Finland, there are two super ministries respectively in charge of S&T development. One ministry is responsible for infrastructure, basic research and applied research, while another ministry is mainly in charge of technology development and application. The two super ministries manage over eighty percent of government R&D budget. Two or three other ministries may collaborate with them in the S&T development, featuring simplicity in the horizontal division of labor.

Some countries distribute the task of S&T development evenly among the majority of ministries, despite the concentration of budget [17]. The tendency is clear when ministries for traditional sectors (such as nature resource,

agriculture or fisheries industries) are strong. In Japan, the Netherlands, Norway, Canada, although more than half of the overall R&D budget is managed by one ministry (or department), almost every ministry is respectively in charge of related S&T development ranging from infrastructure, research, development and application, with own research institutes. Those ministries that manage large R&D budget may act more like the coordinator for other ministries and assist them in the driving of overly dispersed S&T tasks.

Countries such as UK, Korea, Israel and US, both R&D budget and tasks are distributed among most of ministries. They do not have super ministries as mentioned above to serve the function of entire competence chain, nor coordinating ministries which manage the most part of the R&D resource. Instead, they demonstrate clear departmentalism in the horizontal dimension of function. For instance, there are seven departments in the US which are all involved in S&T development. Each of them is responsible for infrastructure to research, development and application, with specific research institutes attached to each department. In other words, departments are required to be more specialized in certain domain. S&T development will rely more on integration of sectoral practice from each department. The division of labor horizontally becomes more complicated as the departmentalism is significant [17-19].

III. PATTERNS OF S&T GOVERNANCE

In sum, S&T governance patterns differ according to the division of labor at both vertical and horizontal dimensions. Countries can be grouped into four major categories, according to the degree of concentration of authority and responsibility on both vertical and horizontal directions described above:

1) *Concentrated*: it is a combination of both less vertical and horizontal distribution of functions. Division of labor is simple, with high integration ability. Policies are formulated and executed by few entities. It is represented by Denmark, Germany, Switzerland and Sweden. Macro-level policies are largely formed through one super ministry. These super ministries are the Ministry of Science Technology and Innovation in Denmark, the Ministry of Education, Research and Culture in Sweden, the Federal Ministry of Education and Research in Germany, and the Federal Ministry of Interior Affairs in Switzerland. These super ministries themselves are highly integrated mechanisms and manage over-half R&D budget. They have strong control and the authority in term of S&T development.

2) *Hierarchical*: it is a combination of wider vertical distribution and less horizontal distribution of functions. Macro-level policies are formed through a collective mechanism by which sectoral interests are also represented. But the tasks of execution concentrate on one or two ministries. It is represented by Finland and France. French or Finnish macro-level policies are decided by High-level bodies (policy council/committee) led by the President or by the Prime Minister. The final decision/policy will be implemented largely by one or two selected ministries. In France, there are Ministry of National Education, Advanced Instruction and Research, and Ministry of Economy, Finance and Industry. In Finland, Ministry of Education and Ministry of Trade and Industry are selected ministries. These selected ministries of respective

countries initiate R&D activities, including linkage development of competence building from scientific research, applied research, and technology development to commercialization. They are responsible for the management of around eighty percent of national R&D budget. The mechanism of governance is close to a top-down process, from top leaders to special council of ministers, to the selected ministries, and finally the program managing agencies.

3) *Sectoral*: it is a combination of less vertical distribution and wider horizontal distribution of functions. The top leaders work more like coordinators for macro-level policies. Both decision-making and execution are mainly subject to departments, where sectoral interests are strongly guarded. It is represented by US, Canada and Norway.

4) *Nested*: it is a combination of both wider vertical delegation and horizontal division/coordination. The process of decision making is depending on a collective mechanism. The execution function is also distributed among respective ministries, instead of executing through one or dual departments. It is represented by UK, the Netherlands, Japan, Taiwan and Korea.

IV. THE CHALLENGES OF INTEGRATION

Different authorities or agencies typically have different rationales, stakeholders, resources and policy measures. Within the current governance structure, it is often documented that administrative entities frequently have a range of objectives which cannot easily be reconciled and may be in conflict. Compromise across ministerial and sectoral interests is not easy [20][21]. Effective integration and coordination among organisations have become critical for governance.

A. Co-ordination through Organization

The government can create an entity that covers a broad range of players with wider responsibilities. Policy councils or committees are often considered excellent models of a high-level body capable of coherent and efficient governance of macro-level policies. Council members are major player of the government, and sometimes representatives from research or industrial communities are also involved. With the support of professionals and external experts, all members work together to reach common policy goals [22][23]. This top-down but consensus-based approach commonly adopted by the government of Finland, Japan, UK, Korea, and France. These governments set up high-level policy councils or committees within the Cabinet to deliver authoritative, negotiated policy recommendations.

For Finland, macro-level policies are made in permanent councils within the Cabinet. The Cabinet contains Economy Council, National Council for Information Society and Science and Technology Policy Council (STPC) [24]. STPC has been established since the 1990s to serve as the organization for the policy coordination and integration. It has a comprehensive membership, with key Ministers, representatives from other institutions and agencies, as well as stakeholders. Regular members include Minister of Education, Minister of Trade and Industry and Minister of Finance. The Council aims to assist Cabinet on major decision-making and support policy planning for each ministry or department, e.g., setting agendas, planning

development strategies, managing international cooperation, and advising on the distribution of expenditure. STPC has been very influential in directing the process of priority setting. It also works through the process between several specialized committees and task forces. The objective is to minimize the differences between policy planning and execution, and to achieve integration among fields and among departments. These special committees are respectively led by the Minister of Education and Science, and the Minister of Trades and Industry. Task forces can be established according to the themes and supervised by the Ministers of major departments in the concerned issue. Most importantly, supporting staff of the Council are gathered by related ministries or agencies for administrative support. Such closely-linked characteristics showed strong intension for both horizontal and vertical integration. Not only core ministries are required to work under the pressure of the Council, responsible ministries are designated to promote policy development and strive towards common goals, since they all join to some degree in the preparation for the common agenda. Problem encountered in the execution process can also feedback through this mechanism, greatly minimizing the gap and disadvantages if all ministries work independently.

Similar design can be observed in Japan since a large scale administrative reform began in the new millennium. Council for Science and Technology Policy (CSTP) has been established as the headquarters for national science and technology policy. The council is consisted of Director-General, who is also the Minister of State for Science and Technology Policy, Cabinet members, and representatives outside the government. Bureau of Science and Technology Policy (BSPT) is placed under the Council as the secretariat. It contains more than one hundred of specialists recruited from the private sector. Plenary meetings of CSTP have been held regularly on a monthly basis with the participation of the Prime Minister. CSTP is tasked to oversee government-wide R&D policy measures and activities and to exert its leadership to co-ordinate related policy measures and activities when necessary [25]. Apart this high-level policy council, several Councils and Headquarters are also established within the Cabinet Office to deal with specific technological fields that have national importance. For instance, IT Strategic Headquarters and IT Strategic Council under the Cabinet Office, are the main places where cross-cutting issues for the development of information technology are discussed and decision are made. The Director-General of IT Strategic Headquarters is the Prime Minister himself, while the Deputy Director is also the Minister of State for Science. These council and headquarters are powerful tools for reaching consent in the priority-setting process.

Apart from the above mentioned examples, organizations such as National Science and Technology Council (NSTC) in Korea, Ministerial Committee on Science and Innovation (SI) in UK, and Inter Ministerial Science and Technology Committee (CIRST) in France, are all set up within the Cabinet and play similar function as mentioned.

B. Co-ordination through Policy Framework

Although coordination through organizational changes is not uncommon in many countries, this type of reform often bears relatively high cost. Some government change policy and programme design from hierarchal style to more network-type initiatives, such as framework policies, making them joint efforts across ministerial or other institutional boundaries [26] [27]. Framework policies are policy packages including a hierarchy of overall priorities, areas of effort, sub-areas priorities, and a range of different policy programmes, policy instruments and policy actions. Framework policies are often guided by common visions which are necessary for a horizontal, coherent and long-term commitment [27-29]. This plan-based approach is more easily adopted in countries where the capability of planning regime is strong. Japan's S&T Basic Plan is formulated to offer this type of comprehensive agenda. The Basic Plan set governmental goals, defines strategic priority areas and identify the need to reform the national innovation system as a whole. The purposes are to integrate innovation as a driver in economic growth and to provide directions for developing and implementing policy. Switzerland is a landmark for R&D Master Plan, which is made of comprehensive presentation the background, vision, short to midterm goals, strategies and applications of research. Norway also has produced a national-level action plan for information society (e-Norway) [30]. Above all, Taiwan and Korea all have introduced framework-type R&D programmes, which aim to group a number of measures and R&D projects with clear policy targets.

C. Co-ordination through Selected Agents

For some government, drastically changing the rule of policy design or introducing new schemes are relatively difficult. Ministers without Portfolio or Administrative Ministers are appointed and work as important interface for policy integration [31] [32]. These positions are often granted critical status in the policy formulation process by the leaders. While Executive Ministers are responsible for the management of policies in ministries, Administrative Minister, on the other hand, are also responsible for the planning and negotiation of non-executive policies and specialized policy issues among ministries, under the Prime Minister's command. This requires a considerable effort to stay up to date on political processes at different levels. Japan, Korea and Taiwan are good demonstrations of using selected ministers as the drivers for policy integration.

The policy-making in Japan works by strengthening the cabinet organization, involving Council for Science and Technology Policy (CSTP) and Administrative Ministers (Minister of State for Science and Technology Policy) appointed by the Prime Minister into the core of the policy integration mechanism. Korea is probably the most interesting case. The President himself is the Chairman of National Science and Technology Council established within the Cabinet. The government has revised the relevant laws and regulations in order to promote the Minister of Science and Technology to Deputy Prime Minister. Therefore he can serve

as the Vice Chairman of NSTC, Minister of S&T and Deputy Prime Minister at the same time [31][32]. The laws commission him to supervise not only planning, co-ordination and evaluation of S&T-related policies but also to co-ordinate and allocate the government budget [33]. Since several organizations are placed under the supervision of same person, the coherence of policy decision-making was naturally reinforced. Also, efforts are also made to deliberately rotate top officials over the ministries on average a new position every five years. This might also be one of the alternatives to facilitate future interdepartmental governance.

D. Co-ordination through Communication

The government can encourage more communication with coordinating organizations or stakeholders through changing policy-making processes and procedures. Ad hoc Policy Platforms established by some government already put the idea into practice. The Innovation Platform in the Netherlands, with high-level representatives from the government, industry and universities, was chaired by the Prime Minister himself. The Platform has a small secretariat and is not an official advisory committee. It is not established by law and has no budget. The purpose of such platform is to offer suggestions for improving the linkage between firms and the public knowledge infrastructure [34]. As an ad hoc co-ordination mechanism, the Innovation Platform is based on the high profile of its members more than on its official status. However, this type of communication is not uncommon. Science, Technology and Innovation System in Denmark, which was established recently, shows a similar idea.

V. CONCLUSION

Recent developments in governmental reform have already seen a great degree of de-centralisation in response to the demand for dynamism. Since there have been a wider distribution of power and tasks across many representatives and government bodies, integration and coordination among agencies have become critical issues for keeping the policy-making away from fragmentation. It implies not only a need to broaden the focus from the original platform to a more generic policy areas, but also the possibility to reorganize institutions, procedures and practices for cross-sectoral policy making. Different alternatives implemented by different countries should be further evaluated and learned in order to reach the best practice of governance.

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